the report of the committee of ten appointed by the National Educational Association upon the courses of instruction in secondary schools.

DR. EDMUND J. JAMES, professor of public finance and administration in the Wharton School of Finance and Economy, and professor of political science in the graduate department of the University of Pennsylvania, has accepted the professorship of public administration at the University of Chicago.

RICHARD E. DODGE, of the department of geography in Harvard University, has been appointed instructor in geography and geology in the Teachers' College, New York.

THE University of Pennsylvania expects an increase in the number of students in almost every department. The Freshman Class in the medical school numbers about 250, and the upper classes include 50 students from other institutions.

DR. ARTHUR D. FRIZELL has been appointed associate professor of mathematics in the University of the City of New York.

CORRESPONDENCE.

THE ABSORPTION OF TERRESTRIAL RADIATION BY THE ATMOSPHERE.

IN the issue of SCIENCE for August 16th Professor Hallock's account of Langley's bolometric studies contains the following statement: "Our atmosphere acts like a valve, transmitting in almost undiminished strength the short quick waves of energy radiated to us from the sun, but refusing absolutely to return the long slow waves in which the earth tries to radiate the energy back into space. Without this atmosphere we should all have been frozen long ago" (p. 178).

This leads to an interpretation of Langley's results so different from that which I have gathered from his writings that a brief comment on the subject seems desirable. It seems to me that Langley has shown that the solar rays find the atmospheric valve badly clogged when they attempt to pass inward through it, and that the terrestrial rays find the valve very leaky when it tries to prevent their passage outward.

In the first place, regarding the entrance of solar rays, Langley found from his observations at Allegheny and Mt. Whitney that about half their energy is lost in passing down through clear air. He drew a curve to represent the distribution of energy in the spectrum of the high sun at Allegheny; the area included between the curve and its horizontal base line corresponding to 1.7 on a scale of calorics. Another curve was constructed on the same base, but with ordinates representing the inferred distribution of energy in the solar spectrum outside of the atmosphere; the area here included corresponding to 3.5 calorics ('Researches on Solar Heat,' Prof. Papers, U. S. Signal Service, XV., p. 144 and pl. XV.). Later statements increase the average percentage of transmission of the solar beam to 70% ('The Temperature of the Moon,' Mem. Nat. Acad. Sciences, 1888, IV., 89); but a valve that could, when open, allow only 70% of a current to pass through it would be regarded as a very imperfect mechanism.

In the second place, the action of the atmosphere on rays emitted from the earth is inferred chiefly from its action on rays emitted by the moon and by experimental radiators. The moon's spectrum is shown to consist of two parts; one part being simply reflected sunlight with its maximum energy in rays of 'luminous' wave-lengths; the other part being true lunar rays, emitted by true lunar radiant action, with their upper and lower limits at wave-lengths of one and perhaps fifty μ, and their maximum energy in wave-lengths of seven μ. These latter are in a spectral region of which no one had any knowledge whatever before Langley's studies about 1886. The solar rays, infra-reds as well as luminous and ultra-violet rays, are transmitted by glass, but the true lunar rays are entirely cut off by glass and must be studied with rock-salt prisms. The ratio of the energy of the solar rays reflected by the moon to that of the true lunar rays is as one to seven (Mem. N. A. S., IV., 197; or Amer. Journ. Science, Dec., 1889, 435). As is the case with the rays

from other solid radiators, the lunar beam has the greatest quantity of energy in rays of greater wave-length than those of its maximum energy (A. J. S., 435), and this is a matter of great importance in the present connection. The air is practically opaque to the strongest of these rays, of wave-length about seven μ, for it is here that the 'great cold band' of the lunar spectrum occurs; yet in the region of the great body of coarser but weaker lunar rays the percentage of transmission rises to 70 or 80 (Mem. N. A. S., pl. 6 and 7; A. J. S., pl. X. and XI.). The average transmission of the whole lunar beam of emitted rays is estimated at 40% (Mem., 189). A valve with a leakage of 40% should not be spoken of as 'absolutely refusing' to let a current pass; it should hardly be called a valve at all. Assuming that terrestrial and lunar radiations are much alike, Langley's results seem to show that something more than half of the solar beam comes in through clear air, and something less than half of the terrestrial beam goes out. It can be only by the small amount of energy thus saved to our use that the temperature of the earth is maintained.

Regarding the process by which the earth maintains its existing temperature, there is an interesting suggestion by Prof. Arthur Searle, of the Harvard College Observatory, in a brief essay entitled 'Atmospheric Economy of Solar Radiation' (Proc. Amer. Acad. Arts and Sci., XXIV., 1888, 26–29), to which those who are interested in this problem may refer, and from which I quote the following sentence in order to show how others than myself read Langley's conclusions: "The hypothesis which has been current until recently with regard to this protective action of the atmosphere depended upon a supposed effect of selective absorption, which has now been largely, if not entirely, disproved by Langley's experiments" (p. 26).

The following quotations may indicate Langley's position regarding the 'valve' or 'trap' or 'hot-bed' action of the atmosphere: "Allegheny observations * * * show that a considerable part of this radiated [lunar] heat does pass through our atmosphere along with that reflected" (Science, 1st Ser., Jan. 1, 1886, 8). "Contrary to all previous experience, it [the lunar beam] nevertheless reaches us, thus bringing evidence of the partial transparency of our terrestrial atmosphere even to such rays as are emitted by the soil of our planet" (Mem. N. A. S., 193). "To see how the question of the lunar heat affects our knowledge on the whole subject of our planet's temperature, we must remember that until a few years past it had been assumed by all writers of repute that the earth's atmosphere acted exactly like the glass cover of a hotbed, and kept the planet warm, in exactly the same way that the hotbed is warmed, by admitting the light-heat of the sun, which was returned by the soil in the invisible radiations of greater wave-length to which the atmosphere was supposed to be impervious, and that thus the heat was stored" (Mem., 110). Although no equally explicit announcement is made of the belief with which Langley would replace this assumption made by 'all writers of repute,' these extracts and quotations give reason to think that Professor Hallock's brief statement is over-strong in using such phrases as 'almost undiminished' and 'refusing absolutely.' The analogy of the valve needs so much qualification that it is not very serviceable in the way of explanation.

In this connection, a few words may be added on the matter of terminology, which I find very embarrassing. We all recognize that the careful definition of scientific terms is an important aid to careful thought, and that the use of a term loosely and vaguely is apt to tangle up the ideas of the hearer or reader, if not of the speaker or writer. The introduction to Maxwell's 'Theory of Heat' offers an excellent illustration of the care with which that masterful physicist used his terms (Appleton's Edition, 1883, p. 8, 9. He afterwards says: "Heat is certainly communicated from one body to another by a process which we call radiation, which takes place in the region between the two bodies. We have no right, however, to speak of this process of radiation as heat. We have defined heat as it exists in hot bodies, and we have seen that all heat is of the same kind. But the radiation between bodies differs from heat * ** in being of many different kinds * * When we speak of radiant heat we do not mean to imply the existence of a new kind of heat, but to consider radiation in its thermal aspect"

(p. 15, 16). Yet, even Maxwell speaks of 'heat rays,' almost as if they objectively possessed heat, and, of course, with the implication that 'rays of light' are not 'heat rays.' Can it be urged too strongly that the rays differ objectively only in wave-length and amplitude, and that their relations to heat and light are entirely and absolutely subjective? Yet loose phrasing is continually met with. Langley writes of 'luminous heat' and of 'the radically different character of the heat in these two maxima' (A. J. S., ut supra, 434, 435). Hallock writes: "Then it was that heat was recognized as another manifestation of those periodic disturbances, or waves, in that elastic medium which was then known as the luminiferous ether, and which is now universally known as 'the ether' (SCIENCE, ut supra, 174). Perhaps this refers to the mis-recognition of the early part of this century; perhaps professional physicists get along comfortably enough with 'dark heat rays' and the rest; but to those who have to use physical results in other lines of study, this indefinite phraseology is very troublesome.

W. M. DAVIS.

HARVARD UNIVERSITY, Sept. 30, 1895.

SHELLS AS IMPLEMENTS.

PLEASE call the attention of those who own or have charge of archæological cabinets to an illustration in von den Steinen's 'Unter den Naturvölkern Zentral Brasiliens,' 1894, p. 207, fig. 27. A fresh water mussel shell has a hole through it just as you see in specimens on plate xxvi. of Holmes' paper 'Art in Shell.' But von den Steinen says that these shells are used as scrapers; the edge on large objects and the hole through the shell is also used by the tribes living on the upper Shingu for smoothing or scraping wood. His next remark about pushing the hole in with an Akuri nut I do not comprehend.

O. T. MASON.

THE INVERTED IMAGE ON THE RETINA.

IN the last number of this journal (p. 438) Professor Brooks writes: "We all believe many things which are inconceivable, such as the truth that the image in our eyes is upside down." But why is this inconceivable? To those having knowledge of elementary physics it is inconceivable that the image should not be inverted. Perhaps Professor Brooks means that it is incomprehensible that we should see things right side up when the image is upside down. This is sometimes urged, but would seem to be sufficiently answered by a remark once made by Lotze in the presence of the writer: "If any one is troubled by the fact that the image is inverted, let him suppose that the soul stands on its head." It is, indeed, quite as reasonable to suppose that the mind stands on its head as to suppose that it stands on its feet and looks at the image on the retina —which would seem to be the assumption of those who are troubled by the phenomenon.

A similar paradox is the fact that with two images on the retinas we see things singly. This may also be treated without undue seriousness by the question: "If we hear a baby crying with two ears, why do we not think it is twins?

J. McK. C.

SCIENTIFIC LITERATURE.

Mental and Physical Fatigue by M. MOSSO. Translation by P. Langlois. (Bibliothèque de philosophie contemporaine.) Paris, Félix Alcan. 1894.

The Difference Between the Muscles in Their Normal and Their Abnormal, or Fatigued Condition by M. WEDENSKY. Archives de physiologie; Comptes rendus de l'Académie des Sciences.

It is but recently that problems of this nature have been treated by physiologists.

Kronecker, in his experiments on the detached muscles of the frog, succeeded in obtaining 1,000, even 1,500 contractions, the intensity of which decreased regularly in proportion to the increase of fatigue; thus, for contractions at regular intervals, produced by currents of equal intensity, the curve of fatigue is a straight line. Kronecker also observed the great individual differences existing in animals in their power of resistance to fatigue.

M. Mosso, the author of the present work (unfortunately abridged in the French translation), is an Italian physiologist who has undertaken with an instrument of his own invention,